Claims

1. A process for producing colored spherical polymer particles using microchannels including a first microchannel through which a colored continuous phase is transferred and a second microchannel through which a spheroidizing phase of a fluid medium flows, said colored continuous phase and said spheroidizing phase being in an O/W (oil-in-water) or W/O (water-in-oil) relationship with each other, said colored continuous phase of one or at least two colors being successively discharged from said first microchannel into said spheroidizing phase to form colored spherical polymer particles, which process comprises the steps of:

transferring said colored continuous phase comprising an oily or aqueous fluid medium containing a polymerizable resin component and further containing a color dye/pigment insoluble in said medium into said first microchannel;

then successively discharging said colored continuous phase into said aqueous or oily spheroidizing phase flowing through said second microchannel either continuously or intermittently; and

then polymerizing and curing said polymerizable resin component in said spheroidizing phase while successively

spheroidizing said discharged colored continuous phase in said spheroidizing phase.

2. The process for producing colored spherical polymer particles using microchannels according to claim 1, wherein said polymerizable resin component is polymerized and cured under UV irradiation and/or heating.

3. The process for producing colored spherical polymer particles using microchannels according to claim 1 or 2, wherein a colored continuous phase comprising dyes/pigments of two or three different colors in respective separated phases is formed as the colored continuous phase within said first microchannel and is then discharged into said spheroidizing phase to successively form colored spherical polymer particles having two color or three color phases.

4. The process for producing colored spherical polymer particles using microchannels according to any of claims 1 to 3, wherein said colored continuous phase comprises separated phases of two or three colors selected from achromatic colors including white and black or chromatic colors including red, blue, green, purple, and

yellow.

5. The process for producing colored spherical polymer particles using microchannels according to any of claims 1 to 4, wherein said polymerizable resin components constituting two separated phases in said colored continuous phase are polymerizable monomers, one of which is positively electrifiable and the other is negatively electrifiable, and said spherical polymer particles with two color phases are designed to have electrification characteristics of a positive electrode and/or a negative electrode.

6. The process for producing colored spherical polymer particles using microchannels according to any of claims 1 to 5, wherein said polymerizable resin component constituting two separated phases in said colored continuous phase are a polymerizable resin component with positively magnetizable powder and negatively magnetizable powder dispersed therein and said spherical polymer particles with two color phases are designed to have electrification characteristics of a positive electrode and/or a negative electrode.

7. The process for producing colored spherical polymer particles using microchannels according to any of claims 1 to 6, wherein spheroidization is carried out so that the volume average particle diameter is in the range of 1 to 400 μm and the degree of distribution of the average particle diameter is not more than 5% in terms of relative standard deviation value.

8. An apparatus for producing colored spherical polymer particles using microchannels including a first microchannel through which a colored continuous phase comprising an oily or aqueous fluid medium containing a polymerizable resin component and further containing a color dye/pigment insoluble in said medium is transferred and a second microchannel through which an aqueous or oily spheroidizing phase flows, said colored continuous phase and said spheroidizing phase being in an O/W (oil-in-water) or W/O (water-in-oil) relationship with each other, said colored continuous phase being discharged either continuously or intermittently from said first microchannel into said spheroidizing phase in the second microchannel to form colored spherical polymer particles,

wherein a third microchannel and a fourth microchannel for supplying respective different colored

fluid media for forming two phases as the colored continuous phase within said first microchannel are joined to said first microchannel on its liquid inflow end port side so that said third microchannel and said fourth microchannel are provided so as to cross each other at a predetermined angle and to be coplanar with said first microchannel and said second microchannel, and

said first microchannel and said second microchannel are cylindrical, and the liquid outflow end port side of the cylindrical first microchannel for transferring the colored continuous phase is joined to the cylindrical second microchannel, through which the spheroidizing phase flows, at an acute angle, a right angle or an obtuse angle as the crossing angle in the direction of flow of said spheroidizing phase.

9. An apparatus for producing colored spherical polymer particles using microchannels including a first microchannel through which a colored continuous phase comprising an oily or aqueous fluid medium containing a polymerizable resin component and further containing a color dye/pigment insoluble in said medium is transferred and a second microchannel through which an aqueous or oily spheroidizing phase flows, said colored continuous phase

and said spheroidizing phase being in an O/W (oil-in-water) or W/O (water-in-oil) relationship with each other, said colored continuous phase being discharged either continuously or intermittently from said first microchannel into said spheroidizing phase in the second microchannel to form colored spherical polymer particles,

wherein said first microchannel and said second microchannel are cylindrical, and the liquid outflow end port of the cylindrical first microchannel for transferring the colored continuous phase is joined to the liquid inflow end port of the cylindrical second microchannel, through which the spheroidizing phase flows, in the coaxial straight direction,

a third microchannel and a fourth microchannel for supplying respective different colored fluid media for forming two phases as the colored continuous phase within said first microchannel are joined to said first microchannel on its liquid inflow end port side so that said third microchannel and said fourth microchannel are provided so as to cross each other at a predetermined angle and to be coplanar with said first microchannel and said second microchannel, and

a side microchannel for supplying or supplying/circulating said spheroidizing phase is provided

on both sides on the same plane around said joining site between said first microchannel and said second microchannel so that said side microchannels cross each other in the direction of transfer of the colored continuous phase within said first microchannel at an acute angle or a right angle.

10. The apparatus for producing colored spherical polymer particles using microchannels according to claim 8 or 9, wherein, at the joining site between said third microchannel and said fourth microchannel, for supplying respective different colored fluid media for forming said colored continuous phase comprising two color phases within said first microchannel, which are joined to respective both sides of said first microchannel, a fifth microchannel for forming an additional colored continuous phase of a different one hue is joined to said first microchannel in its liquid inflow end port.

11. The apparatus for producing colored spherical polymer particles using microchannels according to any of claims 8 to 10, wherein the liquid outflow end port in said second microchannel connected in the coaxial straight direction to said first microchannel comprises a plurality

of discharge openings provided, on the side face of a recovery tank for said spherical particles, at equal intervals on the same plane toward the central axis of said recovery tank.

12. The apparatus for producing colored spherical polymer particles using microchannels according to any of claims 8 to 11, which comprises a control system adapted for providing a uniform particle diameter, said control system comprising a particle diameter measuring device and a mechanism for regulating the flow rate in said first microchannel and said second microchannel.